Journal of
Water & Climate Change

IWA PUBLISHING

Journal of Water and Climate Change Vol 14 No 4, 1226 doi: 10.2166/wcc.2023.411

Understanding the conflict and cooperation in the Yarlung Tsangpo-Brahmaputra River Basin under climate change: a quantitative view based on water events

Yue Zhao [a,*], Tingting Zhao [a], Xuefei Xiong[a] and Yukun Sun[b]

[a] College of Law, Sichuan University, Chengdu, China
[b] College of Law, China University of Political Science and Law, Chengdu, China
*Corresponding author. E-mail: zhaoyue@scu.edu.cn

YZ, 0000-0002-6667-3342; TZ, 0000-0002-1768-2082

ABSTRACT

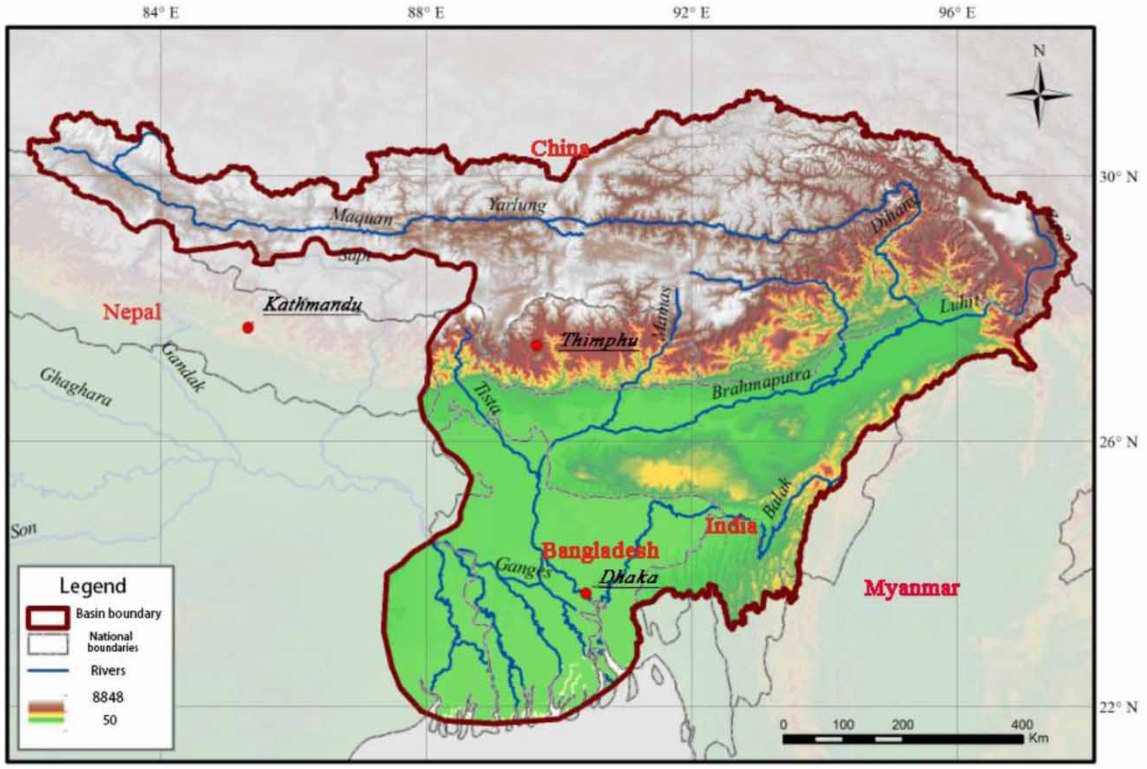
The Yarlung Tsangpo-Brahmaputra River Basin (YBRB) has long been troubled by the competitive water development activities of India, China, and Bangladesh. While energy thirst and food security keep challenging the riparian States, climate-related changing monsoon pattern increases the potential for conflicts over scarce water. Based on a quantitative analysis of 400 water events spanning the years 1958–2020 of the basin, this research tries to provide a holistic understanding of the conflict and cooperation and explore the possibility of water war or 'climate-based' water war in the basin; and thus formulate more precise recommendations to help prevent and mitigate conflicts. The results of this quantitative research surprisingly reveal that, instead of being main causes of bilateral conflict in the basin, the 'energy imperative' and the 'climate imperative' have become two major catalysts for water cooperation in the basin, water war is therefore highly unlikely. However, current bilateral cooperation on climate change mainly involves 'climate adaptation'; few efforts have yet been made cooperatively in the field of 'climate mitigation'; while traditional disputes around food and energy persist, the imperative of ecological protection and the lack of attention to cooperative climate mitigation are set to intensify potential conflict in the YBRB.

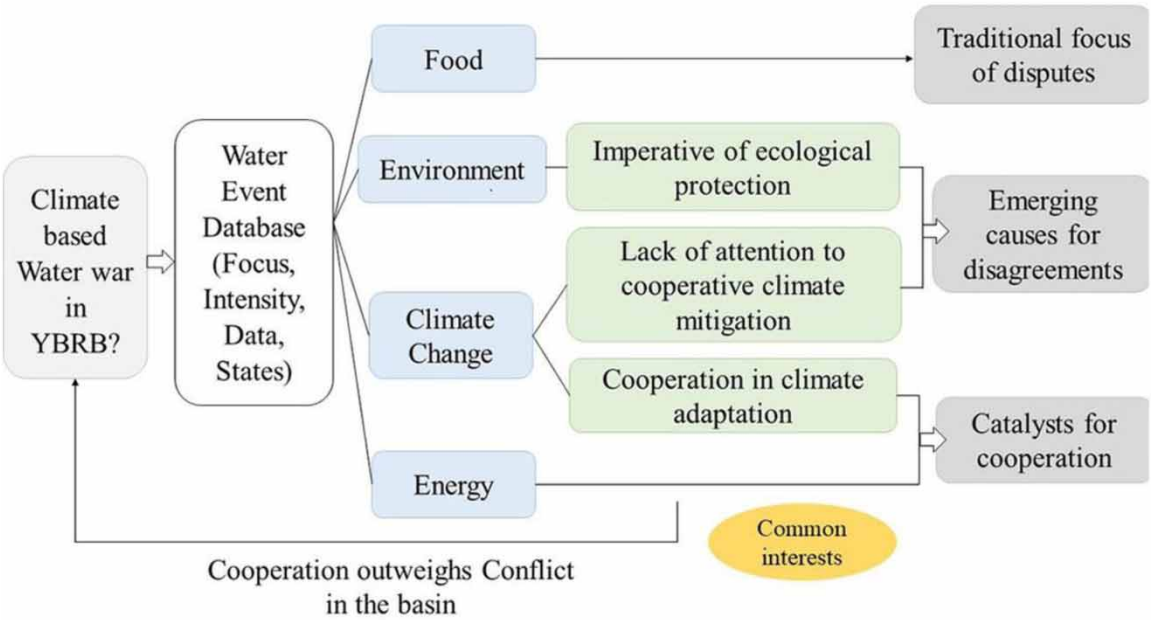
Key words: climate change, conflict, cooperation, Yarlung Tsangpo-Brahmaputra

HIGHLIGHTS

- Four hundred water events focus on food–energy–environment–climate change.
- Database about conflict and cooperation around water, food, energy, and climate change (floods and droughts) in the Yarlung Tsangpo Basin countries.
- 'Secondary states' in balancing the interest between India and China.

GRAPHICAL ABSTRACT





ABBREVIATIONS

BAR Basins at risk
GBM Ganges–Brahmaputra–Meghna
IDSA Institute for Defense Studies and Analyses
IWED International Water Events Database
JRC Joint River Commission

MOU Memorandum of understanding
TWAP Transboundary Waters Assessment Program
WEDB Water Event Database of Brahmaputra Basin
YBRB Yarlung Tsangpo-Brahmaputra River Basin

1. INTRODUCTION

Starting from an elevation of 5,300 m, the 2,880 km-long Brahmaputra River originates as the Yarlung Tsangpo in Tibet. After making a spectacular U-turn, it plunges through the world's deepest gorge and bursts onto the Assam Plain of India, announcing itself as the Brahmaputra. Finally, the river is joined by the Ganges and Meghna in Bangladesh; together, these rivers form the world's largest delta before emptying their waters into the Bay of Bengal. In all, the river crosses five countries – Nepal, China, Bhutan, India, and Bangladesh – forming part of the vast Ganges–Brahmaputra–Meghna (GBM) Basin.

The Yarlung Tsangpo-Brahmaputra River Basin (YBRB), which is a part of the grand GBM Basin, was identified as one of the most significant risk hotspots by both the Basins at Risk (BAR) project (Wolf 2003) and the Transboundary Waters Assessment Program (UNEP-DHI 2016; Wolf 2003). In 2010, the Institute for Defense Studies and Analyses (IDSA 2010) also expressed its concern and fear that the issue of Yarlung Tsangpo-Brahmaputra water could emerge as a key factor in determining the future relationships among the YBRB states (IDSA 2010). As the main source of water, energy, and food for an estimated 130 million people, the basin is under great pressure for development as populations keep growing and climate change continues to manifest. China, India, and Bangladesh, three highly populated developing countries all have strategic interests in the shared water of the basin. Their thirst for energy and increasing concern for food security have fostered fierce competition over water resources in the region (UNEP-DHI 2016). Meanwhile, the basin is also facing the growing threat of ecological degradation (Badrzadeh *et al.* 2022) and climate change.[1]

In this context, some even warn of the potential for 'water wars' in the region (Chellaney 2013; Christopher 2013), as the lack of basin-wide cooperation has left the YBRB vulnerable to short-term-oriented, competitive exploitation and unilateral overdevelopment without consideration of climate change, which may further reinforce the division and generate more disputes (Smith & Vivenkananda 2017; Biggs 2018). Studies on the complex, dynamic, interactive, and interdependent relationship among different conflict factors for conflict also provide an understanding of the water–energy–food–climate nexus (Lawford *et al.* 2013; Yue & Guo 2021; ADPC 2022) in the YBRB. These studies emphasize the influence of hydropower development in the basin on the downstream resilience to climate change and rises the attention on the potential for 'climate-based water war' (Scheffran & Battaglini 2011; Klare 2020). Owing to global warming, the Brahmaputra is expected to receive more water from Tibetan snow and glacier melt (Kumar *et al.* 2021), the whole basin is under the threat of water-related disasters (Suwarno *et al.* 2021). Climate change also poses a great threat to the global food system and the irrefutable impacts of climate change on the food system have recently been acknowledged (Kadhim *et al.* 2022). Bangladesh, India, and Nepal have been identified as 'facing a high risk of armed conflict as a knock-on consequence of climate change' (Shrestha *et al.* 2015; Smith & Vivenkananda 2017), as the changing monsoon pattern would leave one or more riparian countries unable to secure enough water to produce their desired energy and food and therefore, increases potential for conflicts over scarce water (Yang *et al.* 2016). The long-lasting water disputes related to the water scarcity and unilateral hydropower development activities of two major states in the basin – India and China increase further the possibility for 'water wars'. (IDSA 2010; Christopher 2013; French 2014; Keskinen *et al.* 2016; Pak 2016).

On the other hand, others argue to the contrary, as 'water development always fuel greater interdependence', instead of causing wars (Delli Priscoli & Wolf 2009; Wouters & Chen 2013), and a form of preliminary cooperation has already been developed in the basin (Smith & Vivenkananda 2017; Xie & Jia 2017). There's also evidence that the possible mainstream hydropower development can contribute significantly to basin-wide benefits through transboundary cooperation in the YBRB, as the reservoir storage can not only bring more hydropower productivity (Siderius *et al.* 2022), but also increase the minimum flow during the dry season, providing a higher assurance rate of irrigation water requirements and mitigating flood damage in Bangladesh and India (Lyu *et al.* 2023).

[1] In the Transboundary Waters Assessment Programme (TWAP), the Ganges–Brahmaputra–Meghna Basin was identified for having "high climate-related risks". In the TWAP, basins with high economic dependence, low levels of societal wellbeing and high exposure to floods and droughts have the highest climate-related risks. Available at: http://twap-rivers.org/assets/GEF_TWAPRB_FullTechnicalReport.pdf (Accessed on 15 July 2021).

To sum up, whether current water disputes in YBRB would grow into a water war or a climate-based water war remains a mystery. Events data-based empirical study on the role of the state player in the conflict and cooperation and the role of potential factors for water conflict and cooperation could possibly help solve the mystery. The water events data are 'the most detailed record of diplomatic interactions available in quantitative form' to the international water relations research community (Goldstein 1992). Considering the current lack of comprehensive, reliable and objective international water events data[2], this research created a new water events data set, which covers 400 water events in the YBRB, the Water Event Database of Brahmaputra Basin (WEDB).[3] Based on the recorded water events data, four potential factors for conflict and cooperation were identified: energy thirst, food security, degrading aquatic ecological environment, and climate-related water disasters. By conducting quantitative analysis based on the 'water events data' of the YBRB, this research tries to build a comprehensive, objective local-scale database about water-related interactions occurring between co-riparian countries in the YBRB and thereby (1) provide a holistic understanding of the status quo of conflict and cooperation in the YBRB; (2) identify significant trends and anticipate disputes; and thus (3) formulate precise recommendations to help prevent and mitigate conflicts between neighbouring countries.

2. METHODOLOGY

Newspapers have increasingly been recognized as a valid proxy to track societal values or public opinion on water issues (Quesnel & Ajami 2017). According to Cooper (2005), official state news can provide an accurate image of the water events that have taken place along the river basin since it comes from media outlets that are typical of the specific country or sector they are published in. We can therefore examine the water interactions along the YBRB by using media news coverage of water events, particularly the factual component of which is recognized by the state as a major data source.

This research focuses on the YBRB, covering water interactions between five riparian countries: China, India, Bangladesh, Nepal, and Bhutan. To better understand conflict and cooperation over shared freshwater resources in the YBRB, the present researchers created the WEDB through two steps: data collection and data compilation.

2.1. Step 1. data collection

Following the traditional definition in the BAR event database, in this research, water events are defined as 'instances of conflict and cooperation' that occur within the YBRB and involve at least two of the five riparian nations along the Yarlung Tsangpo-Brahmaputra River (Yoffe & Larson 2001). First, to locate event data information, the researchers conducted a manual keyword search of multiple electronically searchable news databases, relevant governmental websites, and the International Water Events Database (IWED) (Table 1). Most event data were gathered by the WEDB from news articles. Given criticisms about bias and hyperbole in the news media, we focused only on the events *per se* without considering subjective comments in news reports.

Keywords were carefully designed to include (1) all possible names of the Yarlung Tsangpo-Brahmaputra River and its tributaries; (2) all relevant riparian countries and other participants; and (3) the potential focus of water events. Given the many possible keyword combinations and the difficulty of event extraction from news reports, the manual search was a formidable, time-consuming task. It yielded 12,216 results. The researchers then eliminated duplicates and irrelevant events, ultimately delineating 400 water events (Table 2).

The researchers followed quite different steps when searching the existing water events database, the IWED. As the grand 'GBM Basin targeted by the IWED is far bigger than the YBRB, the researchers' first task involved narrowing down the geographical scope of events to the YBRB. They first conducted a preliminary keyword search in the IWED and located 422 water events. Then, some of these events were directly included in the dataset, coded under the category 'Brahmaputra' or combinations involving its tributaries (Feni/Brahmaputra, Teesta/Brahmaputra, Tista River/Yalu Zangbu, etc.). Other events, including those related to the GBM Basin (coded as 'GBM/Ganges/Ganges', 'Farakka/Ganges', 'Padma/Ganges', 'BRA/Ganges', 'Ichhamti River/Ganges', 'Mahakali River/Meghna', etc.) and those with no target basin specified, underwent manual elimination of irrelevant data; ultimately, 191 water events were extracted from the IWED. After eliminating

[2] Developed at Oregon State University in collaboration with UNESCO-PCCP, the International Water Events Database (IWED) is probably the most comprehensive event database devoted solely to water-related interactions (de Stefano *et al.* 2009, Bernauer *et al.* 2012). However, the IWED is global in scale and it only covers data for 87 events directly related to the YBRB; more detailed water-event data covering only the YBRB are not yet available.

[3] See Water Event Database of Brahmaputra Basin (WEDB), available at: http://47.94.249.80/ (Accessed on 20 February 2023).

Table 1 | Water events collection

Search terms:	Terms and connectors
Insert:	Yarlung Tsangpo OR Yarlung Zangbo OR Yalu Zangbu OR Brahmaputra OR Jamuna OR Siang
In:	Headline, Lead Paragraphs, Full text
AND:	**Parties:** China OR India OR Nepal OR Bangladesh OR Bhutan OR Assam OR Arunachal Pradesh **Focus:** Water OR river OR dam OR diversion OR irrigation OR agriculture OR environment OR pollution OR ecological damage OR climate change OR flood OR energy OR international cooperation **Names of Tributaries:** Siang OR Feni OR Juri OR Teesta (Tista) OR Jinjiram OR Nitai OR Muhuri OR Bhairab OR Mathabhanga OR Sonai OR Manu OR Bijni OR Dudhkumar OR Nagar OR Dhalai OR Umiam
In:	Headline, Lead Paragraphs, Full text
AND NOT:	Sea OR ocean OR human names OR Brand names
Source	**Bangladesh:** The Daily Star, Banglanews 24; *Ministry of Foreign Affairs, Ministry of Water Resources were NOT included as only available in Bengali* **Bhutan:** Kuensel, Ministry of Foreign Affairs **India:** India Today, The Economic Times, Ministry of External Affairs, Central Water Commission **Nepal:** The Kathmandu Post, Ministry of External Affairs; *Ministry of Energy, Water Resources and Irrigation were NOT included as only available in Nepali* **China:** Xinhua, China Meteorological News Press, Ministry of Foreign Affairs, Ministry of Water Resources, Ministry of Ecology and Environment **Event dataset:** Transboundary Freshwater Dispute Database (TFDD)-International Water Events Database (IWED)

duplicates and irrelevant events, the final number of events extracted from the IWED was 87[4]. The IWED was the main source of events dated before 2010, while other news and government websites mainly provided events dated after 2010 (Table 2).

2.2. Step 2. data compilation

The goal in creating the WEDB was to identify all reported instances of conflict or cooperation in the YBRB, which would serve as the basis for further analysis. Researchers coded all located data according to date of event, involved riparian countries, source of information, intensity of event (based on the BAR scale; Table 3),[5] and focus of conflict – next, focuses of conflict were further classified according to interactional drives: energy (e.g. hydropower), food (e.g. irrigation, agriculture), environment (e.g. water quality, pollution, ecological damage), and climate (e.g. flood, drought, climate change). (Wirsing *et al.* 2012)[6] Events with implications for multiple imperatives (such as the creation of joint commissions, disputes over the sharing of water resources in general, etc.), were double-coded and -counted.

This study has potential limitations. Firstly, water events are extracted from media and news reports, which are likely to focus on eye-catching events (especially conflicting ones) and likely to overlook other less important events. It may possibly

[4] It is worth noting that, as the Farakka barrage does not locate within the Yarlung Tsangpo-Brahmaputra River the Yarlung Tsangpo-Brahmaputra River basin or the Yarlung Tsangpo-Brahmaputra River Basin, all related events, though great in number, were therefore excluded. Similarly, events related to the Ganges Water Sharing Treaty were also deleted.

[5] Water Event (BAR) Intensity Scale, Available at: http://www.cs.com.cn/xwzx/hg/201507/t20150705_4749205.html (Accessed on 15 July 2021).

[6] Similar classifications of focuses could be found in the works of Wirsing *et al.* (2012).

Table 2 | The source of events

Sources	Approximate years covered	Initial search results	Number of relevant events	The final number of events
TFDD-IWED	1951–2008	422	191	87
The Daily Star	1997–2020	1,050	196	153
Banglanews 24	2010–2018	972	26	18
Kuensel	2015–2019	2,234	34	28
The Economic Times	2010–2020	1,314	49	46
The Kathmandu Post	2016–2020	850	22	13
Beijing Xinhua	2013–2019	985	7	6
China Meteorological News Press	2010–2019	453	3	3
Ministry of Foreign Affairs (Bhutan)	/	345	0	0
Ministry of External Affairs (India)	2006–2019	727	44	37
Central Water Commission (India)	2019	662	1	0
Ministry of External Affairs (Nepal)	/	791	0	0
Ministry of Foreign Affairs (China)	2009	941	5	2
Ministry of Water Resources (China)	2008–2019	687	7	6
Ministry of Ecology and Environment (China)	2017	203	3	1
Total Events	1951–2020	12,216	588	400

Table 3 | BAR scale

– 7	Formal declaration of war
– 6	Extensive war acts causing deaths, dislocation, or high strategic cost
– 5	Small-scale military acts
– 4	Political-military hostile actions
– 3	Diplomatic-economic hostile actions
– 2	Strong verbal expressions displaying hostility in interaction
– 1	Mild verbal expressions displaying discord in interaction
0	Neutral or non-significant acts for the inter-nation situation
1	Minor official exchanges, talks, or policy expressions – mild verbal support
2	Official verbal support of goals, values, or regime
3	Cultural or scientific agreement or support (non-strategic)
4	Non-military economic, technological, or industrial agreement
5	Military economic or strategic support
6	International Freshwater Treaty; Major strategic alliance (regional or international)
7	Voluntary unification into one nation

lead to the overrepresentation of some particular events in the data set. Secondly, the newly established dataset focused solely upon the international dimension of transboundary water use in the YBRB (Table 3, BAR scale); the domestic aspect of transboundary water use has not been recorded in the dataset, therefore, how domestic factors (such as the public participation, the engagement of other stakeholders, the domestic water use policy and water conservancy technology, etc.) interact with international hydro-politics is not considered and evaluated. Lastly, as the earliest year for which this research retrieved was

1958 and the search language was English, earlier years (before 1958) and media in other languages are therefore under-represented in the results.

3. RESULTS

The WEDB covers 400 water events in the YBRB spanning the years from 1958 to 2020, involving all five co-riparian states: 231 events for 'food imperative', 103 events for 'energy imperative', 146 events for 'climate imperative', and 87 events for 'environment imperative'.

3.1. An overview

In general, we found the following in relation to parties, focus of conflict, and scale of conflict:

3.1.1. Parties: bilateral strategy prevails; India is the most active participant

A bilateral strategy prevails in water interactions in the YBRB due to the lack of a basin-wide cooperative framework. Both India and China were firm practitioners of bilateralism. Among 400 events, only 16 multilateral interactions were found; most of these multilateral interactions involved India, Bangladesh, Nepal, and Bhutan, including cooperative interactions between Nepal, Bangladesh, Bhutan, and India under the framework of the South Asian Association for Regional Cooperation (SAARC). China only appeared in six multilateral events, involving potential cooperation over food, energy, and flood control.

Next, focusing on each riparian state's role in water interactions, India, Bangladesh, and China were the three core states (Figure 1) and the midstream India was the most active participant in the management and development of the water resources in the basin. This finding is the opposite of the general belief that the Sino-Indian water relationship is the sole centre in the basin (Holslag 2011; Mahapatra & Ratha 2016). On one hand, India figured in the largest number of events. The WEDB had recorded 332 events involving the participation of India, representing over 83% of the total events, while Bangladesh was present for 251 events (62.7%) and China for only 147 events (36.5%). On the other hand, different from upstream China, which mostly engaged in exchanges with India and Bangladesh, India actively interacted with every riparian state in the basin. According to this research, the participation of Bhutan, which is situated entirely within the YBRB, is nevertheless very limited. Neither China nor Nepal was found to interact with Bhutan in located bilateral events. Quite contrary to the general assumption taking India and China as the sole central international relationships in the basin, in the WEDB, the most common country-pair is India and Bangladesh; they were identified as having engaged in almost half of the identified water interactions (47.7%), while India and China appeared only in 22.5% of total events.

From the perspective of time, interactions between India and Bangladesh have grown faster than those for any other two country-pairs during the last 10 years (Figure 2), while the interactions between China and Bangladesh even slightly declined during the same period of time. Though water interactions between India and China are not as active as those between India

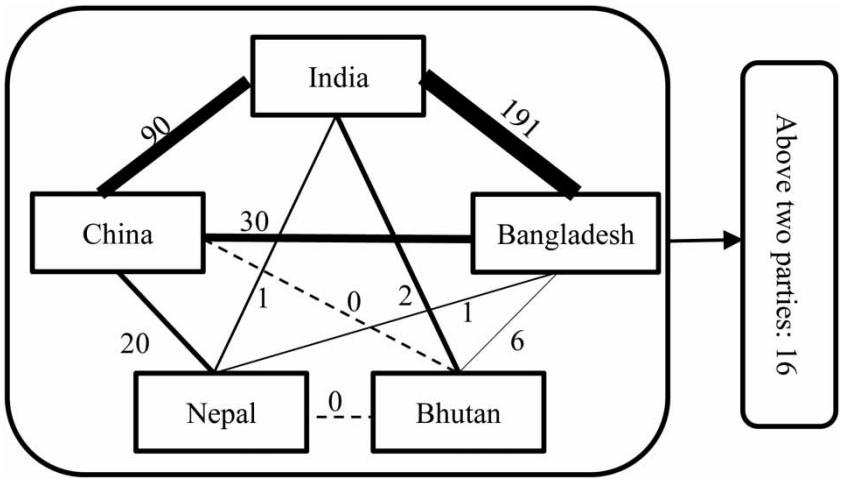


Figure 1 | Core states in water interactions.

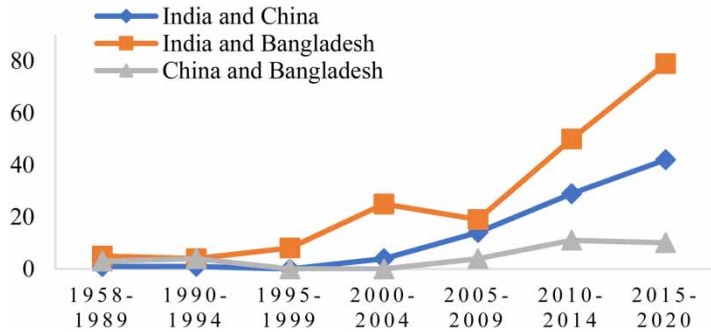


Figure 2 | Time distribution of events – country-pairs.

and Bangladesh in history, bilateral interactions between India and China have started to grow quickly ever since 2005. To illustrate the causes of this evolution, the focuses of interactions as well as the scale of conflict will be explored in the following sections.

3.1.2. Focuses: interactions on hydropower prevail while cooperative interactions on climate change grow quickly

As mentioned above, there is intense debate over the causes of conflict in the YBRB. According to the research, there are four main drivers of regional water conflict in the YBRB: the competitive agricultural use of water ('food imperative'), climate-related floods and droughts ('climate imperative'), hydropower development ('energy imperative'), and the ever-growing concern about water pollution and ecological damage ('environment imperative')[7]. Among these causes, while the food imperative has been dominating regional water interactions, the importance of the climate imperative is constantly increasing. This trend has accelerated, especially during the last decade, as the climate imperative has become the second-most important motive for water interactions in the YBRB, whereas the regional concern for environmental protection still remains relatively weak when compared with the other three causes (Figure 3). Due to the rapidly burgeoning regional population and the attendant economic and social challenges, the YBRB is facing great pressure of economic development and food security; consequently, achieving sustainable development of the basin is not the regional states' primary concern, as they seem to prioritize economic growth over sustainability.

However, this does not mean environmental issues are no significance in the basin. Quite to the contrary, when focusing on the scale of conflict of water events, the relatively infrequent environment imperative is the only focus, which has generated more conflicts and disputes (−7 to −1 Figure 4) than cooperative interactions (1–7 in Figure 4, while '0' events are 'neutral interactions'). According to the research, 48.2% of environment-related events are 'conflict interactions', while this percentage is only 38% for food, 28.7% for climate change, and 15.5% for energy. This shows that while riparian states, by means of cooperative development of agricultural and industrial projects along the Yarlung Tsangpo-Brahmaputra River,

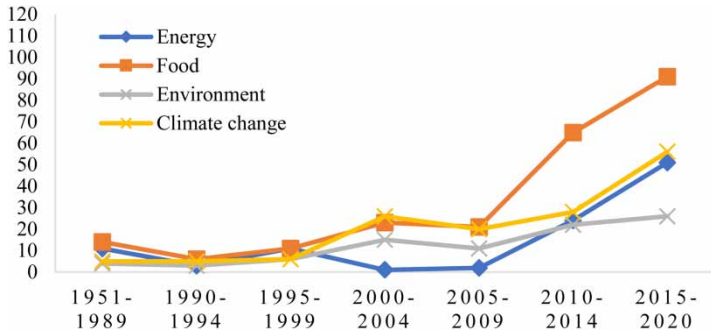


Figure 3 | Time distribution of events – focuses.

[7] See "Step 2. Data compilation".

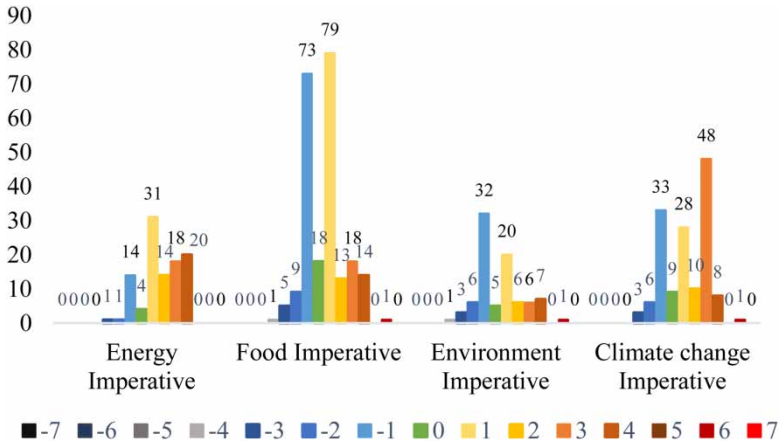


Figure 4 | Distribution of events: scale of conflict/focuses.

struggle to satisfy the economic and social needs of local populations, the lack of attention to environmental protection has conversely become an important cause of disagreement in the YBRB. It is also worth noting, however, that there is an obvious causal relationship between energy/food-related events and environment-related events. The identified environment-related conflict interactions mainly involve complaints about the degradation of water qualities or drop in water level and the consequent loss of ecological flow in the downstream of the Brahmaputra caused by upstream construction of dams[8] and major diversion of the waters[9]. Therefore, most environment-related events are also categorized under other categories of focus (mostly food and energy).

Moreover, the researchers also noted a trend of rising energy-related interactions in the YBRB (Figure 3); during the last decade, the energy imperative has surpassed the environment imperative to become the third-most important driver. Curiously, however, the energy imperative, instead of becoming the main source of conflict, has proved to be a major catalyst for water cooperation in the basin, revealing a positive reciprocity between hydropower benefits and benefits for states (Middleto & Devlaeminck 2021). These findings echo earlier research that suggests 'while past and current water resources development in the region has brought challenges and risks associated with changes in the river system, these have not led to widespread destruction of livelihoods and conflict among riparian countries' (Kittikhoun & Staubli 2018), on the contrary, 'the possible mainstream hydropower development can contribute significantly to basin-wide benefits through transboundary cooperation in the YB River basin' (Lyu *et al.* 2023). Similarly, the second-most prominent focus among the four, the climate imperative, also involves mainly positive interactions (1–7). These include the regular provision of hydrological information during the flood season[10], joint research on Himalayan glacier melts, and others. As Aaron T. Wolf once insightfully pointed out, 'water is so important, nations cannot afford to fight over it. Instead, water fuels greater interdependence' (Wolf *et al.* 2006; Delli Priscoli & Wolf 2009). In the case of the YBRB, this interdependence mainly involves the common interests of the highly populated basin states in ensuring their national energy security and addressing the challenge of climate change (Smith & Vivenkananda 2017).

[8] In 2013, Hydrologists in Bangladesh have expressed concerns over the operation of 23 Indian hydropower projects, saying the launch of these power plants would further reduce water flow and affect the river's ecosystem. And in 2017, India expressed "concern" over the contamination of the Siang River in Arunachal Pradesh to the Chinese Foreign Minister. Roy (2013). See also Kalita (2017)

[9] For example, Bangladesh has protested against India's river-linking project as it "would cause an ecological disaster to Bangladesh". A non-governmental national committee in Bangladesh launched a protest leaflet campaign against India's mega river-linking project. In the leaflet, the movement calls upon all countrymen to resist the proposed Indian project that will withdraw waters from common rivers in 2003. See the TFDD. Available at: https://transboundarywaters.science.oregonstate.edu/content/data-and-datasets (Accessed on 15 July 2021).

[10] For example, China informed India about a landslide in Yaluzangbu and activated the Emergency Information Sharing Mechanism to share hydrological data on an hourly basis in October 2018. Chaudhury & Bureau (2018).

3.1.3. Scale of conflict and cooperation: more cooperative hydro-political interactions than conflictive ones

According to our research, the majority of the recorded water interactions occurred after 1990 (Figure 5) and fall, most frequently, in the range from −1 to 1 (249 events, Tables 3 and 4). Among 400 water events, 251 events (62.75%) are positive interactions, while only 122 events (30.5%) are negative. Moreover, among negative interactions, the most severe conflict event only reached class −4. It involved a political-military hostile action that occurred between India and Bangladesh in 1994 (registered by TFDD).[11] A further six events were Classified as −3, including the unilateral construction of projects and diversion of water against another country's protests (India and Bangladesh 2003[12], China and India 2013[13], and others). As for the positive interactions, the most positively classified event reached Class 6. It involved a major strategic alliance established between India and Bangladesh in 1974, when the two countries signed the *Statute of the Indo-Bangladesh Joint Rivers Commission*. A further 35 events are Classified as 4, including the provision of technical expertise[14], cooperative project of watershed management[15], the offer of a loan for the implementation of a water development project[16], etc. The distribution of water events shows that, though it is generally believed that the multiple challenges and consequent competition over water resources may trigger further disagreements in the YBRB, riparian states are in fact much more cooperative than generally presumed, and the earlier 'water war' narrative (Chellaney 2013; Christopher 2013) is therefore groundless.

From the time perspective of view, the four most extreme water interactions (one Class −4 event and three Class 6 events) all occurred before 2000. In the new millennium, while most water interactions in the YBRB fall in the range from 4 to −3, the most frequent class is Class 1, followed by class −1 events (Figure 5). This possibly reveals that during the last two decades, regional tensions over water resources have been reduced, but that the scale of water cooperation nevertheless stays at a low level (Yasuda *et al.* 2018). Moreover, though the riparian states have all expressed their willingness to cooperate,

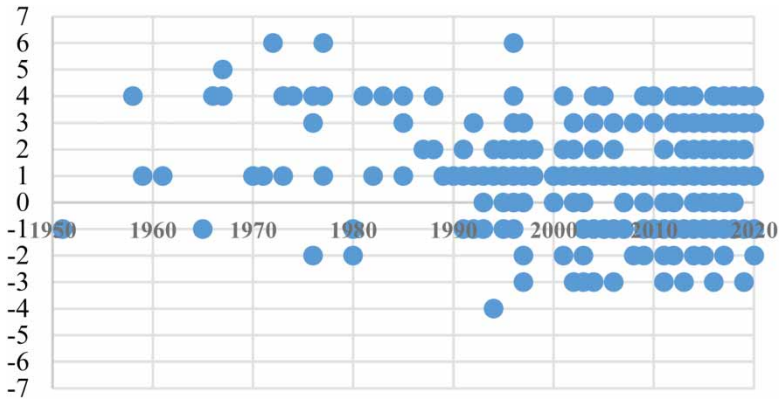


Figure 5 | Time distribution of events – BAR scale.

[11] During a visit by General Joshi to Bangladesh, India planes violated Bangladesh airspace, India massed its troops along the border of the Lamnonirhat District while Bangladesh was conducting excavation work along two of its rivers – the Feni and the Dharal. The Foreign Secretary of Bangladesh said the government is observing the situation along the border and the Home Ministry has lodged a strong protest. See the TFDD. Available at: https://transboundarywaters.science.oregonstate.edu/content/data-and-datasets (Accessed on 15 July 2021).

[12] Bangladesh has accused India of making a decision to follow through with a $US120 billion project to divert water from eastern rivers to its arid west. These actions allegedly violate an international treaty prohibiting unilateral changes to the natural course of international rivers. The UN has been called upon to help resolve the issue. See the TFDD. Available at: https://transboundarywaters.science.oregonstate.edu/content/data-and-datasets (Accessed on 15 July 2021).

[13] The Daily Star reported "that Beijing plans to build new hydroelectric plants on a waterway that the neighbours share. New Delhi has taken an unusually sharp stand against China's unilateral moves to dam the Brahmaputra, saying it has "established user rights" to the river. Asserting itself for the first time, India has asked China "to ensure that the interests of downstream states are not harmed by any activities in upstream areas". Agencies (2013).

[14] For example, the Chinese government strongly supports qualified Chinese enterprises to take part in dredging projects. In September 2011, China Harbour Engineering Company Ltd was selected to implement a project for Jamuna River dredging. Agencies (2012)

[15] The Kathmandu Post reported that "In a first major hydro investment deal between Nepal and Bangladesh, the two countries have signed an agreement to build two hydroelectric plants capable of generating over 1,600 megawatts of electricity in Nepal." Subedi (2016).

[16] For instance, in 2016, the Bhutan–India small development committee endorsed 104 new projects amounting to more than Nu 1.418 billion in the fourth batch of small development projects (SDP), which included new projects on integrated water resources use and management in Thimphu. Palden (2016).

Table 4 | Distribution of events-scale of conflict

BAR scale	Total number
−7	0
−6	0
−5	0
−4	1
−3	6
−2	12
−1	103
0	27
1	119
2	29
3	67
4	35
5	0
6	1
7	0

especially in collecting and sharing hydrological information, conducting joint scientific studies, and even, sometimes, jointly performing water development projects, it is still no less true that the identified cooperative water interactions mainly involve bilateral events; no multilateral basin-wide cooperative framework has yet been established in the basin.

3.2. Bilateral interactions: India–China as the most rivalrous country-pair, with common interests in adapting to climate change

A closer examination of the bilateral interactions for each country-pair could help reveal the trend of the overall hydro-political relationships in the YBRB, thereby helping anticipate and prevent potential conflicts between countries. According to this research, though the recorded water events in the WEDB were scattered over seven country-pairs (Figure 1), the conflictive ones were quite concentrated around two country-pairs: India–China and India–Bangladesh, while China–Nepal, China–Bangladesh, India–Bhutan, and India–Nepal interactions were predominately cooperative (Figure 6). Therefore, a more detailed analysis is conducted on the basis of the bilateral relations of the three 'core riparian states' in the YBRB –

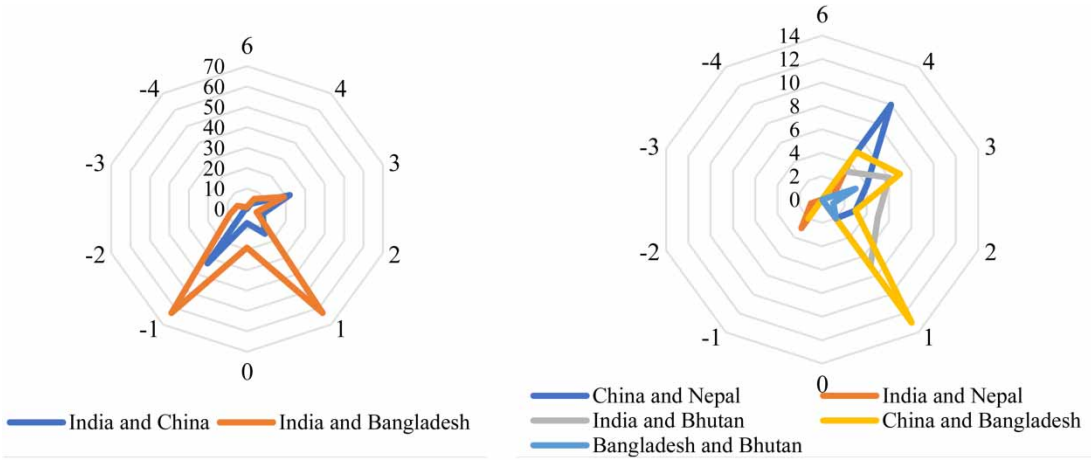


Figure 6 | Distribution of events: country-pairs/number/scale of conflict.

specifically, the relations between India and China and the relations between India and Bangladesh, covering the two most rivalrous country-pairs in the region.

3.2.1. India and China

The WEDB has recorded 90 bilateral events between India and China, including 29 food-related events, 24 energy-related events, 19 environment-related events, and 50 climate-related events (most events involve more than one imperative) (Figure 7). Though India and China are not the most important pair in terms of number of events, they are the most rivalrous among all country-pairs, especially considering the percentage of conflictive events (but, as with overall events, not the absolute number). From the perspective of the conflict scale, while the majority of events are positive interactions, the WEDB has identified 35 conflictive events between India and China (representing 38.8% of the total bilateral events) (Figure 6). These disputes between India and China are mostly centred around the energy imperative and the food imperative (Figure 7). From the perspective of time, over the past two decades, there has been a tendency towards increasing bilateral conflicts and disputes, especially in the fields of energy and environment, while an increasing number of climate-related interactions were also recorded (Figure 8).

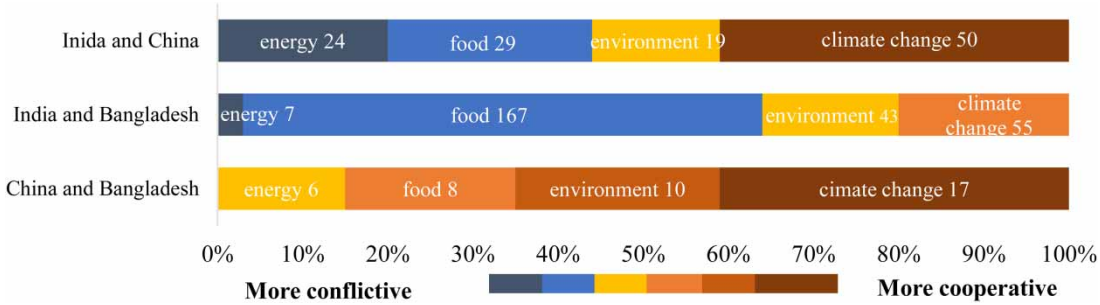


Figure 7 | Distribution of events: country-pairs/focuses (percentage)/scale of conflict.

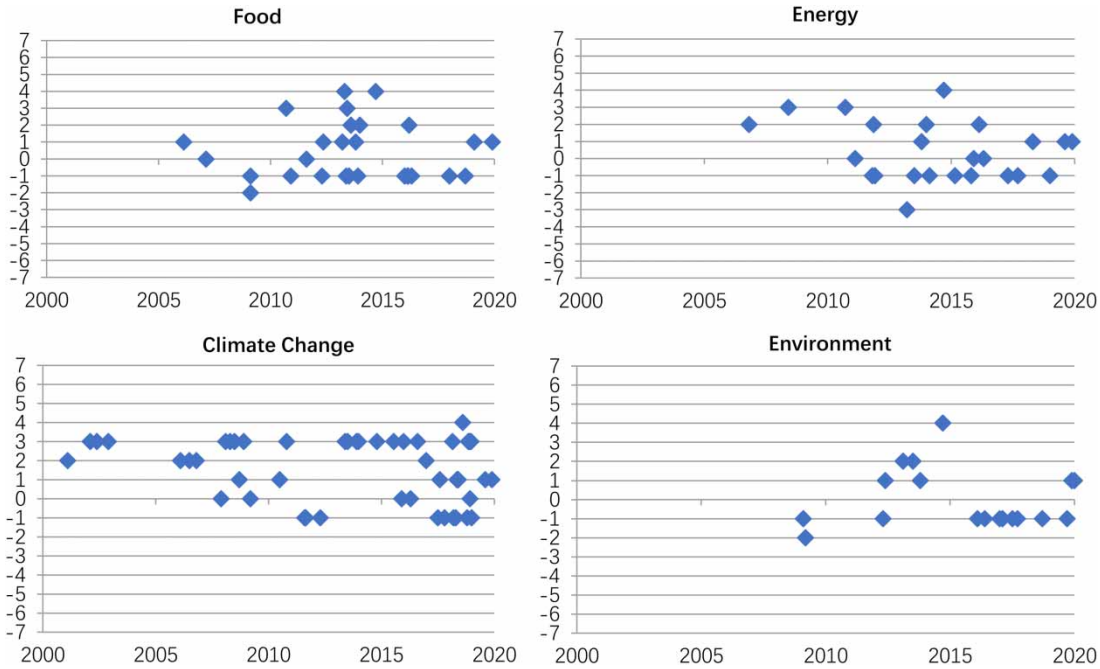


Figure 8 | India–China: distribution of events – time/focus (since 2000).

First, the energy imperative is the most contested area between India and China (50% of energy-related events are negative interactions), while the 'food imperative' is the second most. Most of these disagreements involve speculation about China's water diversion plan and the concern over the construction of hydropower projects in the upstream. According to the WEDB, India and China established an expert-level mechanism to discuss issues relating to the shared rivers in 2006. Following this institutional advancement, Indian news media started to express concern about the lack of water-sharing arrangements between India and China as far back as 2007. In 2009, as China started to construct a major dam (Zangmu Hydropower Project) upstream, the state government of Assam started to complain, fearing that the upstream dams would 'dry up the river Brahmaputra and other water resources downstream'[17]. In 2010, India and China exchanged views on China's plan to construct a hydropower project and the Chinese foreign minister clarified that 'the planned construction is that of a small power project which would not store water and would not have an adverse impact on the downstream areas'. Despite this statement, the development of this project has still sparked fears in India about Chinese intentions. In 2011, the Indian state government even related the construction of the dam to a purported Chinese 'plan to divert the waters of the Yarlung Tsangpo-Brahmaputra River towards the parched provinces in the north-west'. China rejected this speculation and this statement was accepted by the Indian government in 2012, according to which 'the apprehensions about a possible diversion of the Yarlung Tsangpo-Brahmaputra River by China are not correct and [are] devoid of facts'[18]. In 2013, amid warming bilateral India–China ties, multiple cooperative interactions have occurred: India and China developed an information exchange system with China on water flow; India and China also signed the *Memorandum of Understanding (MOU) between The Ministry of Water Resources, Government of the Republic of India and The National Development and Reform Commission, Government of The People's Republic of China on Cooperation in the field of Water-Efficient Irrigation* (the '2013 Irrigation MOU'), aiming at enhancing bilateral cooperation in the field of water-efficient technology with applicability in the area of agriculture, along with exchange of best practices. These bilateral positive interactions seem to have put an end to Indian speculation over China's plan to divert the Brahmaputra, yet disputes over China's hydropower development projects are still growing. In 2014, as the first generator of the Zangmu Hydropower Project was commissioned and more dams were planned and construction started by China, India showed once again its concern over hydropower projects in Tibet. In 2016, the Chinese authorities announced the blocking of a tributary of the Yarlung Tsangpo as part of a hydro project; as a response to the queries of India, China clarified that the reservoir capacity of the project was less than 0.02% of the average annual runoff of the Yarlung Tsangpo. In 2018, Beijing assured India and Bangladesh again that its dams were not designed to store water.

Second, on matters of the environment, ecological degradation and water pollution are two causes of Sino-Indian water interactions. On one hand, as mentioned above, India is concerned about water quantity-related ecological disasters that might be caused by the speculative Chinese plan to divert the river. On the other hand, water quality deterioration is also an important cause of bilateral disputes between India and China. In 2017, the authorities in East Siang District found that the water of the river was not fit for consumption, as it contained heavy slag. After that, India expressed successively for 3 years 'concern' over the contamination of the Siang River (a tributary of the Brahmaputra) and linked the deterioration in the quality of the Siang to the infrastructure construction activities on the Yarlung Tsangpo in China. However, China denied any such link and stating that the situation was caused by an earthquake in the region and was not a human-made incident.

Last, despite all their disagreements, India and China have closely cooperated in the field of climate change (Figure 7). Among 90 events, 50 climate-related interactions were identified and the majority (72%) of these events were positive interactions involving information sharing and emergency management. Since 2002, India and China have signed and renewed a series of MOUs on the provision of hydrological information on the river in flood season for flood forecasting and disaster mitigation – especially from China, the upstream nation, to India. The year 2017 was an exception; after a territorial incident along the disputed Chinese–Indian border (Doklam Plateau), China did not provide the hydrological information to India, attributing the non-provision of data to technical reasons. However, only 1 year later, China resumed the practice, informed India about landslides occurring, and reactivated the Emergency Information Sharing Mechanism to share hydrological data on an hourly basis.

[17] Mustafizur (2009).

[18] Bhattacharya (2012).

It is revealed here that India and China have maintained communications and have already developed a form of preliminary cooperation. Even in the most conflictive field – energy – the two states have established institutional mechanisms to facilitate bilateral communication, especially in case of disagreements (Xie & Jia 2017). They have long cooperated in addressing the challenge of climate change, sharing hydrological and flood forecasting data since 2002, as noted. Various issues relating to trans-border rivers have been discussed between India and China under the ambit of an institutionalized expert-level mechanism since 2006, as well as through diplomatic channels. Thus, although China's current approach is merely a weak positive reciprocity, sharing hydrological information to build trust (Middleto & Devlaeminck 2021) in doing so, some mutual understanding has seemingly already been achieved between these two major powers in the YBRB (Figure 8).

Moreover, a closer examination of the changes in bilateral hydro-political interactions over time also reveals that India–China bilateral exchanges over water are closely related to the general political relations between the two countries, especially around border issues. According to WEDB, during the past 10 years, 2013 and 2018 are two periods when China and India interacted most positively over water issues, while 2017 marked the most intense year of conflict (Figure 9). This distribution of water interactions coincides with the general trend in bilateral political interactions between India and China. For instance, in 2013, after a military stand-off on the disputed border in April, the Chinese prime minister visited India in May and signed a series of MOUs (including the 2013 Irrigation MOU) with India. Following this visit, India and China signed in October a 'Border Defense Cooperation Agreement' and agreed to 'reduce misunderstandings and improve bilateral communications.' The successful resolution of the border incident obviously enhanced mutual political understanding; leading to positive water interactions occurred as well. After that, the two countries seem to have enjoyed the most peaceful period for water interactions between them from 2014 to 2015, 2 years marked especially by the exchange of state visits by both countries' leaders. Similarly, another rise in water interactions after 2017 could also be explained by the warming of bilateral political relations between India and China. However, also in 2017, as another China–India military stand-off occurred on the Doklam Plateau, conflict events over water also experienced a large rise in number. After that, following an informal summit of the top leaders, tensions between the two Asian giants cooled and positive exchanges over shared waters prevailed in 2018 and 2019.[19] In 2020, after the break-out of COVID-19 as well as the military incident along the border, Sino-Indian bilateral relations soured again, and accordingly, bilateral water interactions dropped to almost zero.

3.2.2. India and Bangladesh

As mentioned above, water interactions between India and Bangladesh are the highest in number among all country-pairs (191 events in total; Figure 1). Moreover, from the time perspective, evidence also shows that bilateral hydro-political

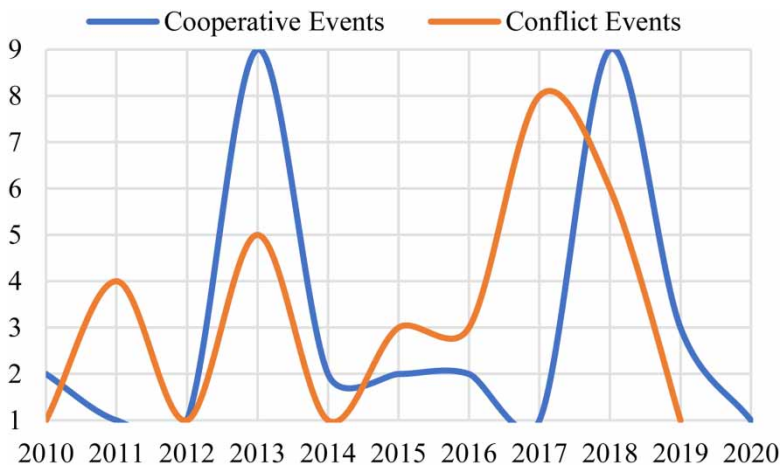


Figure 9 | Time distribution of cooperative/conflict events (India–China since 2010).

[19] Goldman (2020).

interactions between India and Bangladesh have seen rapid growth over the past decade (Figure 3). These water events include 167 food-related events, 55 climate-related events, 43 environment-related events, and 7 energy-related events. They reveal that, on the one hand, disputes and conflicts between India and Bangladesh are mostly centred around the food imperative (Figure 9); on the other hand, while the total number of environment- and climate-related events is not big, their proportion of conflictive interactions is, however, much higher than the food events (Figure 7).

First, among the four focuses, the food imperative is the most important source of bilateral water interactions between India and Bangladesh (Figure 10). The WEDB has identified 167 events related to irrigation and agricultural use of water, including 81 cooperative interactions (48.5%) and 71 conflictive interactions (42.5%). According to the WEDB, the water-sharing issue is a major irritant to bilateral hydro-political relations; indeed, the sharing of the water of the Teesta River, a Brahmaputra tributary, for the purpose of irrigation is the most disputed issue between India and Bangladesh within the YBRB. In 1983, India and Bangladesh signed an ad hoc agreement to share Teesta waters at a meeting of the Joint River Commission (JRC), a bilateral agency founded in 1972, soon after Bangladesh won its independence from Pakistan; in 2001, India and Bangladesh reached an interim arrangement for sharing the waters of the river Teesta. Despite of these bilateral discussions, in 2002, as India unilaterally withdrew water from upstream, thousands of hectares of croplands under Bangladesh's largest irrigation project, the Teesta Barrage Project, remained uncultivated because of a reduction in the flow of water. In 2003, as a response to India's plan to initiate a mega water project to divert waters from major rivers flowing across the border to the drought-prone states of India, major protests were launched in Bangladesh. As India's mega river-linking project may threaten the livelihoods of more than 100 million people downstream, Bangladesh has even called upon the UN to help resolve the issue. In 2004, the two states agreed to hold regular expert-level dialogue on water management and started to undertake a joint scientific survey of water availability in the Teesta River. Since then, many communications have been realized under the framework of this expert-level mechanism. According to the WEDB, Bangladesh has spent almost a decade trying to finalize a water-sharing deal with India on the Teesta. A 'significant movement forward' on the vexed Teesta water-sharing issue occurred in 2010, as the two states exchanged draft agreements on the sharing of Teesta water during a ministerial-level meeting of the JRC. However, the signing of the deal was postponed at the last moment in 2011 due to opposition from West Bengal (in India). The negotiations have made no progress since then.

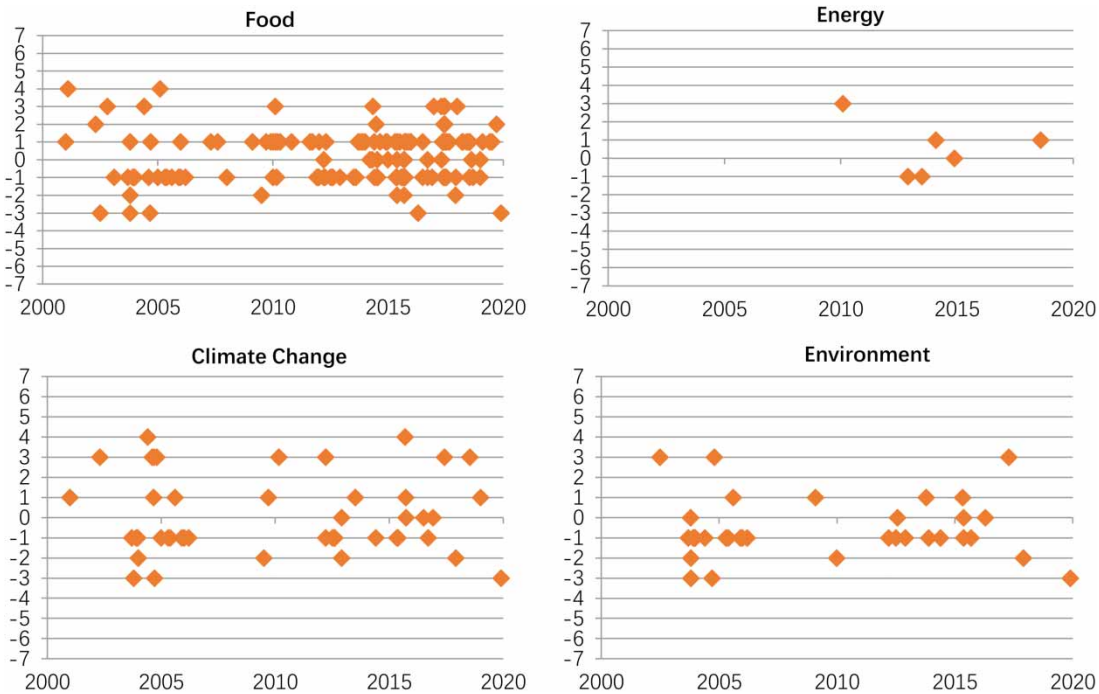


Figure 10 | India–Bangladesh: distribution of events–time/focus (since 2000).

Second, the environmental issue is the most frequent source of conflict between India and Bangladesh. In all, 65% of environment-related events are negative interactions, while cooperative interactions only account for 25% of total environment-related events. These environment-related disagreements mainly involve protests made by Bangladesh to the Indian government. As India plans to link the Brahmaputra to the Ganges to augment the flow and divert it to the southeast and southwest, environmentalists, and political leaders in Bangladesh protest that this river-linking project would create ecological disasters in Bangladesh. However, though a UN report has warned about the impact of increased concentrations of pollutants in the region in 2020[20], transboundary water pollution has not yet become an important issue of dispute between India and Bangladesh.

Third, climate-related disasters are another cause for disagreement between two countries. On one hand, it involves floods caused by the release of excessive water from India during monsoon season. In 2016, due to the heavy flow of water from upstream in India during the monsoon season, Bangladesh faced a serious threat of flood as the Teesta saw an alarming rise. On the other hand, Bangladesh is concerned more often about the drought due to the 'inequitable share of water' during the dry season[21]. According to the WEDB, Bangladesh started to complain about India's unwillingness to share water during dry seasons as early as 1992; as dams and barrages constructed in the Teesta have blocked water flow towards rivers in Bangladesh, similar complaints have been made by Bangladesh ever since 2004 in the WEDB; after more than a decade, in 2019, downstream farmers are still facing difficulties irrigating their crop fields during dry seasons and are also concerned about the fact that 'India's unilateral water withdrawal from upstream badly affects farming and biodiversity in the region'[22].

In spite of these disagreements, there are more positive riparian interactions than negative ones between India and Bangladesh in general. According to the WEDB, India and Bangladesh have long attempted (especially since 1972) to establish a bilateral water management mechanism and have discussed several times the equitable sharing of transboundary water. Even in the fields of environment and climate imperatives, there is no shortage of cooperative interactions. In fact, 42% of the total climate-related events are positive between the two countries, involving especially collaboration on information sharing, which has long provided an important anchor for broader collaboration on transboundary issues. For instance, India and Bangladesh have regularly exchanged hydrological data important for flood forecast warnings; the two states also agreed to jointly collect hydrological data in 2010. Apart from that, India also provided monetary relief to Bangladesh to help recoup losses incurred in the floods. Moreover, the two states have held regular expert-level dialogue on water management of joint rivers and flood control ever since 2004. Scientists from both sides collaborated in mapping the Ganges–Brahmaputra Basin during 2003–2007, which helps reveal signs of droughts and floods to better manage water resources in the region.

A closer examination of the time distribution of conflictive and cooperative events possibly reveals that, quite different from the bilateral relations between India and China, where interactions on water matters have been greatly affected by general relations, the water issue has largely been an independent cause for disagreement between these two countries, which share bonds of history, culture, and a multitude of other commonalities (Figure 11). During the past 10 years, there have been two peak periods of water disputes between India and Bangladesh, the years 2003 and 2012 and neither is attributable to changes in general political relations. First, in 2001, India and Bangladesh had border clashes, but bilateral hydro-political relations stayed relatively calm. Water disputes only arose as a separate issue 2 years later, in 2003, involving India's initial announcement of the massive 'Inter-Linking of Rivers' project. Secondly, in 2011, India and Bangladesh signed the additional protocol for the 1974 Land Boundary Agreement and thereby announced an intention to end the four-decade-old disputes over boundaries. Still, major water disputes occurred in 2012, as West Bengal refused to approve the treaty over concerns about the sharing of Teesta water at the last moment. However, the independence of water interactions from general Indo-Bangladeshi relations is not absolute. In 2015, as India and Bangladesh finally signed the historic *Land Boundary Agreement* to swap enclaves along the border, bilateral water interactions dramatically increased and cooperative events slightly prevailed, as India kept expressing its willingness to cooperate. Despite that, as India and Bangladesh failed in signing the

[20] According to the UN report titled "World Water Development Report 2020" said apart from flooding, Bangladesh will also be the country worst hit by droughts due to increased concentrations of pollutants and low-quality groundwater sources.

[21] For instance, in 2004, due to less flow of water in the river, Teesta Barrage failed to supply irrigation water during the dry season, political leaders in Bangladesh demanded an equitable share of water, especially in the dry season. See the TFDD. Available at: https://transboundarywaters.science.oregonstate.edu/content/data-and-datasets (Accessed on 15 July 2021).

[22] Roy (2019).

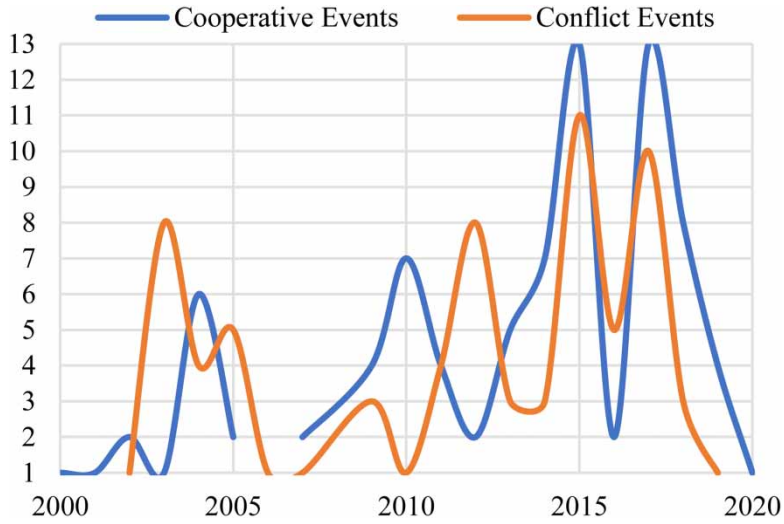


Figure 11 | Time distribution of cooperative/conflict events (India–Bangladesh since 2000).

long-awaited Teesta water-sharing deal during the Indian PM's state visit to Bangladesh in 2015, overall bilateral water interactions significantly declined, and conflictive events prevailed again. In 2017, bilateral exchanges over the Teesta water-sharing deal continued. The PM of Bangladesh paid a state visit to India, wishing to turn the draft deal signed 6 years before into an agreement. However, this effort failed again due to the opposition of West Bengal. In the aftermath of this visit, water interactions between India and Bangladesh declined again.

4. CONCLUSION

The Yarlung Tsangpo-Brahmaputra is undoubtedly one of the most contested rivers in the world. While providing water, energy, and food for an estimated 130 million people, the YBRB is under great development pressure as populations keep growing and climate change continues to manifest. Against this background, there is growing consensus that conflict over shared water resources in the basin is set to intensify.

This research tries to fill the gaps by conducting quantitative water–energy–food–climate analysis based on the 'water events data' of the YBRB and thereby (1) provide a holistic understanding of the status quo, conflict, and cooperation in the YBRB; (2) identify significant trends and anticipate disputes, illustrate the inner mechanisms of the water–energy–food–climate nexus; and thus (3) formulate more precise recommendations to help prevent and mitigate conflicts between neighbouring countries. To fulfil these objectives, the researchers created the WEDB, which covers 400 water events in the YBRB spanning the years from 1958 to 2020, involving all five co-riparian states: China, Nepal, Bhutan, India, and Bangladesh; then the team performed systematic empirical research based on the WEDB, focusing on the changing status quo and the evolution of multiple elements of water interactions, including participants, causes of dispute/cooperation (energy/food/environment/climate change), scale of conflicts, and bilateral interactions of key country-pairs. Following these steps, this research points to a less gloomy picture of hydro-political relations between the YBRB states in the future.

First, despite all the important challenges that the YBRB is facing, cooperation still outweighs conflict in the basin, and hydro-political interactions in the YBRB are in fact much more cooperative than generally presumed. Even the most rivalrous country-pair, India and China, have maintained communications and have already developed a form of preliminary cooperation. Two major powers in the YBRB have seemingly already found a way to resolve related disagreements and some mutual understandings have seemingly already been achieved. Secondly, key country-pairs, while disagreeing with each other mostly over issues related to food and energy are however, willing to cooperate when it concerns preventing and controlling the impact of climate change in the basin. As regards causes of disputes, India and China clash mostly in the fields of energy and food imperatives, while India and Bangladesh disagree with each other especially on food imperatives. Despite these disagreements, China, India, and Bangladesh have good cooperation on climate-related issues, especially on sharing hydrological information, reducing floods and disasters, and managing contingencies. Thus, the

climate imperative has become a major catalyst for water cooperation in the basin. Lastly, it is also worth noting that interesting 'relationship triangles' between India, China, and other riparian states, especially Bangladesh, have also been revealed. Surprisingly, the 'energy imperative', instead of being a main cause of bilateral conflict in the basin, has proved to be another major catalyst for water cooperation in the YBRB. This is mainly attributable to the fact that both India and China have closely cooperated with other basin states in developing hydropower. Though China and India are rivals, they both tend to adopt cooperative strategies with other riparian states in the YBRB, seeking to bring themselves into favour with those states.

In spite of this 'good news', there are still reasons to be cautious about future water interactions in the YBRB.

First, current bilateral cooperation on climate change mainly involves 'climate adaptation'; few efforts have yet been made cooperatively in the field of 'climate mitigation'. This could be problematic, as the growing impetus for 'climate mitigation' on the national level in China and India, two major carbon emitters in the world, would further fuel regional competition over hydropower, which is one important substitute for fossil energy in both countries. It is coupled with a growing concern for water ecological protection of the Yarlung Tsangpo-Brahmaputra River. According to this research, the YBRB is facing great pressure of economic development and food security; consequently, achieving sustainable development of the basin is not yet the states' priority. However, evidence also shows that growing disputes are emerging on environmental issues in recent years, no matter the degradation of water quality or the ecological disasters potentially caused by the diversion of water. While riparian states, by means of cooperative development of agricultural and industrial projects along the Brahmaputra River, struggle to satisfy the economic and social needs of local populations, the lack of attention to environmental protection has instead become a more important cause of disagreement in the YBRB.

Second, the hydro-political relations between riparian states in the YBRB are closely related to general bilateral political trust, especially in the case of India–China. According to the research, there has been no major bilateral conflict triggered solely by competition over water between India and China, and an interesting correlation is uncovered between general bilateral relations and bilateral water interactions. On the one hand, bilateral hydro-political relations always deteriorate when major tensions, caused usually by border issues, occur; on the other hand, bilateral conflict between India and China can sometimes deescalate as water relations are warming up. This possibly indicates that, although political mistrust dominates the hydro-political interactions between India and China, yet strengthening hydro-political ties between India and China could serve as a catalyst for overall bilateral cooperation and eventually help overall bilateral relations return to the 'normal track'. Therefore, two observations can be made: in the first place, the successful prevention and resolution of conflict over water between India and China relies partly upon the improvement of bilateral political trust and the resolution of border disputes; in the second place, current disagreements between India and China can hardly become the oft-predicted 'water war', nor is there any evidence that conflict over shared water resources between India and China 'is set to intensify', as bilateral water disputes have never been the main driver of any actual conflicts in the past. It is quite different in the case of India and Bangladesh. Although these two states also have both border and water disputes, these two aspects did not seem to be closely connected to each other. It is thus revealed that the hydro-political interactions play a much more independent role from other aspects of Indo-Bangladeshi bilateral relations: evidence shows that water disputes have still occurred despite of warming Indo-Bangladeshi relations, while the deterioration of overall bilateral relations between India and Bangladesh has not necessarily led to water conflict.

To conclude, does the international crisis boost cooperation or does it intensify the clash of civilizations? We see both trends during the unprecedented COVID-19 pandemic; it is the same with water issues and the climate crisis. On one hand, it is unnecessary to be overly pessimistic about future hydro-political relations in the YBRB, as evidence shows that the overall water interactions are in fact much more cooperative than generally presumed, and the outbreak of water war in the YBRB seems very unlikely. On the other hand, while traditional disputes around food and energy persist, the imperative of ecological protection and the lack of attention to cooperative climate mitigation are set to intensify potential conflict in the YBRB. In this regard, facing the rapidly changing circumstances of water use in the basin, the highly populated YBRB States are closely interdependent, especially as they share many common interests (Smith & Vivenkananda 2017). Therefore, to prevent further conflict over water in the YBRB, riparian states should first focus on their common interest, especially in fighting climate change and boost cooperation in the area of energy by jointly developing hydropower projects in the YBRB, thereby helping them ensure national energy security and address the challenge of climate change; second, pay special attention to the growing need for ecological protection in the basin and establish cooperative mechanisms to mitigate the

environmental impact of human water use activities; and last, make efforts to improve general political trust between India and China.

ACKNOWLEDGEMENTS

This research is sponsored by the National Social Science Fund of China: "Judicial Response to Climate Change in China" (20CFX064).

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

REFERENCES

Agencies 2012 China–Bangladesh relations have become the model of friendship between countries with different social systems and different cultures. *The Daily Star*. Available from: https://www.thedailystar.net/news-detail-242607 (Accessed on 23 June 2021).

Agencies 2013 Respect river rights, India tells China. *The Daily Star*. Available from: https://www.thedailystar.net/news-detail-267529 (Accessed on 23 June 2021).

Asian Disaster Preparedness Center. 2022 *Climate Change and the Water-Energy-Food (WEF) Nexus in Bangladesh*. 2022-kOFr37-ADPC-WEF_Bangladesh.pdf.

Badrzadeh, N., Samani, J. M. V., Mazaheri, M. & Kuriqi, A. 2022 Evaluation of management practices on agricultural nonpoint source pollution discharges into the rivers under climate change effects. *Science of the Total Environment* **838** (4), 156643.

Bernauer, T., Tobias, B., Buhaug, H., Gleditsch, N. P., Tribaldos, T., Weibust, E. B. & Wischnath, G. 2012 Water-related intrastate conflict and cooperation (WARICC): a new event dataset. *International Interactions* **38** (4), 529–545.

Bhattacharya, P. 2012 India now says diversion by China not true, *The Daily Star*. Available from: https://www.thedailystar.net/news-detail-224774 (Accessed on 23 June 2021).

Biggs, S. 2018 Water management on the Brahmaputra and the applicability of the UNECE water convention. *Vanderbilt Journal of Transnational Law* **51**, 555.

Chaudhury, D. R. & Bureau, E. T. 2018 China shares with India information on the Brahmaputra landslide. *The Economic Times*. Available from: https://economictimes.indiatimes.com/news/politics-and-nation/china-shares-with-india-information-on-brahmaputra-landslide/articleshow/66288379.cms (accessed 23 June 2021).

Chellaney, B. 2013 *Water: Asia's New Battleground*. Georgetown University Press, Washington, DC.

Christopher, M. 2013 *Water Wars: the Yarlung Tsangpo-Brahmaputra River and Sino-Indian Relations*. In: Case Study. US Naval War College, Center on Irregular Warfare and Armed Groups, Newport, RI.

Cooper, S. D. 2005 Bringing some clarity to the media bias debate. *Review of Communication* **5**, 81–84.

Delli Priscoli, J. & Wolf, A. T. 2009 *Managing and Transforming Water Conflicts*. Cambridge University Press, London.

De Stefano, L., De Silva, L., Edwards, P. & Wolf, A. T. 2009 *Updating the International Water Events Database*. UNESCO, Paris.

Feldes, K., 2017 Inter-state conflicts within the Indian National River Linking Project: a case study of the Polavaram Dam. In: *Regional Cooperation in South Asia* (Bandyopadhyay, S., Torre, A., Casaca, P. & Dentinho, T., eds.). Contemporary South Asian Studies, Springer, New York, pp. 173–188.

French, M. 2014 Water wars in the middle kingdom. *International Affairs Review* **22**, 6–30.

Gautam, P. K. 2012 Climate change and conflict in South Asia. *Strategic Analysis* **36** (1), 32–40.

Goldman, R. 2020. India–China border dispute: a conflict explained. *The New York Times*. Available from: https://www.nytimes.com/2020/06/17/world/asia/india–china-border-clashes.html (accessed 23 June 2021).

Goldstein, J. S. 1992 A conflict-cooperation scale for WEIS events data. *The Journal of Conflict Resolution* **36** (2), 369–385.

He, D., Wu, R., Feng, Y., Li Y., Ding, C., Wang, W. & Yu, D. W. 2014 Review: China's transboundary waters: new paradigms for water and ecological security through applied ecology. *Journal of Applied Ecology* **51** (5), 1159–1168.

Holslag, J. 2011 Assessing the Sino-Indian water dispute. *Journal of International Affairs* **64** (2), 19–35.

IDSA Task Force. 2010 *Water Security for India: The External Dynamics*. Institute of Defense and Analysis, New Delhi.

Joshi, N. M. 2013 National river linking project of India. *Hydro Nepal Journal of Water Energy and Environment* **12**, 13–19. doi:10.3126/hn.v12i0.9026.

Kadhim, Z., Khayyun, T. & Alwan, I. A. 2022 Impact of climate change on crops productivity using MODIS-NDVI time series. *Civil Engineering Journal* **8** (6), 1136.

Kalita, P. 2017 Arunachal's Siang River turns black, officials blame China. *The Economic Times*. Available from: https://economictimes.indiatimes.com/news/politics-and-nation/arunachals-siang-river-turns-black-officials-blame-china/articleshow/61846346.cms (accessed 23 June 2021).

Keskinen, M., Guillaume, J. H. A., Kattelus, M., Porkka, M., Räsänen, T. A. & Varis, O. 2016 The water-energy-food nexus and the transboundary context: insights from large Asian rivers. *Water* **8** (5), 193. doi:10.3390/w8050193.

Kittikhoun, A. & Staubli, D. M. 2018 Water diplomacy and conflict management in the Mekong: from rivalries to cooperation. *Journal of Hydrology* **567**, 654–667.

Klare, M. T. 2020 Climate change, water scarcity, and the potential for interstate conflict in south Asia. *Journal of Strategic Security* **13** (4), 109–122.

Kumar, R., Manzoor, S., Vishwakarma, D. K., Kushwaha, N., Elbeltagi, A., Sushanth, K. & Kuriqi, A. 2021 Assessment of climate change impact on snowmelt runoff in Himalayan region. *Sustainability*.

Lawford, R., Bogardi, J., Marx, S., Jain, S., Wostl, C. P., Knüppe, K., Ringler, C., Lansigan, F. & Meza, F. 2013 Basin perspectives on the water–energy–food security nexus. *Current Opinion in Environmental Sustainability* **5** (6). doi.org/10.1016/j.cosust.2013.11.005.

Lim, D. J. & Cooper, Z. 2015 Reassessing hedging: the logic of alignment in east Asia. *Security Studies* **24** (4), 696–727. p. 698, para. 1.

Lim, D. J. & Mukherjee, R. 2019 Hedging in south Asia: balancing economic and security interests amid sino-Indian competition. *International Relations of the Asia-Pacific* **19** (3), 493–522.

Liu, P. 2015 Yarlung Tsangpo-Brahmaputra river in China-India relations: a case of asymmetric interdependence. *Spotlight on Regional Affairs* **xxxiv** (9), 10–11.

Lyu, H., Tian, F., Zhang, K. & Nan, Y. 2023 Water-energy-food nexus in the Yarlung Tsangpo-Brahmaputra River Basin: impact of mainstream hydropower development. *Journal of Hydrology: Regional Studies* **45**, 101293.

Mahapatra, S. K. & Ratha, K. C. 2016 Brahmaputra river: a bone of contention between India and China. *Water Utility Journal* **13**, 91–99.

Middleton, C. & Devlaeminck, D. J. 2021 Reciprocity in practice: the hydropolitics of equitable and reasonable utilization in the Lancang-Mekong Basin. *International Environment Agreements* **21**, 235–253.

Mustafizur, P. 2009 International rivers. *The Daily Star*. Available from: https://www.thedailystar.net/news-detail-89374 (accessed 23 June 2021).

Pak, J. H. 2016 China, India, and war over water. *Parameters* **46** (2), 53–67.

Palden 2016 Bhutan and India endorse 104 new projects. *Kuensel*. Available from: https://kuenselonline.com/bhutan-and-india-endorse-104-new-projects/ (accessed 23 June 2021).

Quesnel, K. J. & Ajami, N. K. 2017 Changes in water consumption linked to heavy news media coverage of extreme climatic events. *Science Advances* **3** (10), e1700784. https://doi.org/10.1126/sciadv.

Roy, P. 2013 Teesta braces for further blow, 23 Indian hydropower projects to be completed by this year, may reduce Teesta flow. *The Daily Star*. Available from: https://www.thedailystar.net/news/teesta-braces-for-further-blow (accessed 23 June 2021).

Roy, S. D. 2019 Teesta, Dharla turn into canals. *The Daily Star*. Available from: https://www.thedailystar.net/country/news/teesta-dharla-turn-canals-1685923 (accessed 23 June 2021).

Sahu, A. K. & Mohan, S. 2021 From securitization to security complex: climate change, water security and the India–China relations. *International Politics* 1–26. doi:10.1057/s41311-021-00313-4.

Scheffran, J. & Battaglini, A. 2011 Climate and conflicts: the security risks of global warming. *Regional Environmental Change* **11**, 27–39.

Shanta, H. A. 2018 Tsangpo-Brahmaputra: a perception study from riparian perspectives. *Journal of Sustainable Development* **11** (3), 33–44.

Siderius, C., van Walsum, P. & Biemans, H. 2022 Strong trade-offs characterise water-energy-food related sustainable development goals in the Ganges–Brahmaputra–Meghna River Basin. *Environmental Research Letters* **17**, 105005.

Smith, D. & Vivenkananda, J. 2017 *A Climate of Conflict: The Links Between Climate Change, Peace and War*. International Alert, London.

Subedi, B. 2016 Bangladesh to build over 1,600 MW hydro projects. *The Kathmandu Post*. Available from: https://kathmandupost.com/money/2016/10/20/bangladesh-to-build-over-1600-mw-hydro-projects (accessed 23 June 2021).

Surie, M. & Prasai, S. 2015 *Strengthening Transparency and Access to Information on Transboundary Rivers in South Asia*. The Asia Foundation, New Delhi, p. 1.

Suwarno, I., Ma'arif, A., Raharja, N. M., Nurjanah, A., Ikhsan, J. & Mutiarin, D. 2021 IoT-based lava flood early warning system with rainfall intensity monitoring and disaster communication technology. *Emerging Science Journal* **4**, 154–166.

UNEP-DHI and UNEP 2016 *Transboundary River Basins: Status and Trends*. United Nations Environment Program (UNEP), Nairobi. volume 3 River Basins, p. xxv.

Wirsing, R., Jasparro, C. & Stoll, D. 2012 *International Conflict Over Water Resources in Himalayan Asia*. Palgrave Macmillan.

Wolf, A. T., Yoffe, S. B. & Giordano, M. 2003 International waters: identifying basins at risk. *Water Policy* **5** (1), 29–60.

Wolf, A. T., Kramer, A., Carius, A. & Dabelko, G. D. 2006 Water can be a pathway to peace, not war. *Navigating Peace* **1**, 1–2.

Wouters, P. 2014 The Yin and Yang of international water law: China's transboundary water practice and the changing contours of state sovereignty. *Review of European, Comparative & International Environmental Law* **23** (1), 67–75.

Wouters, P. & Chen, H. 2013 China's 'soft-path' to transboundary water cooperation examined in the light of two UN global water conventions – exploring the 'Chinese way'. *Journal of Water Law* **22** (6), 229–247.

Xie, L. & Jia, S. 2017 Diplomatic water cooperation: the case of Sino-India dispute over Brahmaputra. *International Environmental Agreements: Politics, Law and Economics* **17**, 677–694.

Xue, H. 2005 China's open policy and international Law. *Chinese Journal of International Law* **4** (1), 133–139.

Yang, Y., Wi, S., Ray, P. A., Brown, C. M. & Khalil, A. F. 2016 The future nexus of the Yarlung Tsangpo-Brahmaputra River the Yarlung Tsangpo-Brahmaputra River Basin the Yarlung Tsangpo-Brahmaputra River Basin: climate, water, energy and food trajectories. *Global Environmental Change* **37**, 16–30.

Yasuda, Y., Hill, D., Aich, D., Huntjens, P. & Swain, A. 2018 Multi-track water diplomacy: current and potential future cooperation over the Yarlung Tsangpo-Brahmaputra River. *Water International* **43** (5), 642–664.

Yoffe, S. B. & Larson, K. 2001 *Basins at Risk: Water Event Database Methodology (Basins at Risk Research Project Chapter 2)*. Oregon State University, Corvallis, OR.

Yoffe, S. B., Wolf, A. T. & Giordano, M. 2003 Conflict and cooperation over international freshwater resources: indicators of basins at risk. *Journal of the American Water Resources Association* **39** (5), 1109–1126. p. 1112.

Yue, Q. & Guo, P. 2021 Managing agricultural water-energy-food-environment nexus considering water footprint and carbon footprint under uncertainty. *Agricultural Water Management* **252**, 106899.

Zhang, H. 2015 China–India: revisiting the 'water wars' narrative. *The Diplomat*, 30 June. Available from: http://thediplomat.com/2015/06/china-india-revisiting-the-water-wars-narrative/.

Zhang, H. 2016 Sino-Indian water disputes: the coming water wars? *Wiley Interdisciplinary Reviews: Water* **3** (2), 155–166.

First received 17 October 2022; accepted in revised form 6 March 2023. Available online 16 March 2023